BUREAU OF RECLAMATION
TECHNICAL SERVICE CENTER
DENVER, COLORADO

TRAVEL REPORT

RES-3.50

Code: 68-68560 **Date**: July 22, 2006

To: Clifford A. Pugh
Manager, Water Resources Research Laboratory (WRRL)

From: Tom Gill, Hydraulic Engineer; Rudy Campbell, Technician

Subject: Travel to Pioneer Irrigation District (near Haigler, NE) to provide assistance with field calibration of submerged orifice structures and an elbow meter structure.

1. Travel period: June 15 - 16, 2006.

2. Places or offices visited: Pioneer Irrigation District (Haigler, NE)

3. Purpose of trip: This trip was a follow-up effort to preliminary field calibration performed in October of 2005. During October calibrations, a source of uncertainty was the ability to accurately read upstream and downstream water levels at the submerged orifice structures. Subsequent to that visit, PID had installed staff gages in the orifice boxes. We also planned to re-install a Continuous Flow Meter (CFM) on the elbow meter which had been set up as a field demonstration site.

4. Synopsis of trip: We arrived at PID mid-morning on Thursday, June 15th and met with ditch superintendent Dan Korf and ditch rider Lynn Holman. We first visited a site where a submerged orifice is installed in a concrete box located on the outside of the canal bank. With this configuration, the orifice box walls are above ground. We drilled holes through the box walls and installed 1/8" pipes for pressure taps both upstream and downstream of the orifice. Clear plastic "sight tubes" were attached to the pipes. The tubes were routed to come together at a point below the elevation of the top of the orifice opening, then proceed vertically to the top of the box wall. The purpose of installing the taps and manometer tubes was to enable reading the differential head using a single staff gage. Once this installation was completed, we left this site to allow sealant applied to pipes installed in the holes bored in the concrete to cure overnight.

Thursday afternoon, we visited the elbow meter site and performed discharge calibrations. For the calibration process, a Controlotron ultrasonic transit-time flow meter was mounted on a section of 10 inch aluminum irrigation pipe. A pipe bend was installed at the discharge end of the metered pipe section to assure pipe-full flow. The calibration was performed by recording discharge rates for a series of flow rates representing the range of expected delivery flows at this site. The corresponding water level differentials observed in manometer tubes attached to taps on the inside and outside of the metered pipe elbow and recorded with each measured discharge.

After completing flow calibrations, the CFM unit which had initially been installed at this site in September of 2005 was re-installed. A programming glitch which had caused computed discharge to be displayed as a negative value (also of unrealistic absolute value) led to the unit being returned to the lab in October of 2005. Unfortunately, upon re-installation, the CFM unit displayed the same functional problem. (See Conclusions section)

On Friday (06/16) morning, we returned to the submerged orifice site where the taps through the box wall and sight tubes had been installed the previous afternoon. This site is characteristic of the smaller (4" X 22") of two submerged orifice sizes the district has installed. Calibrations were performed at this site in a manner similar to that described for the elbow meter calibrations. The site tubes provided an improvement in the ability to determine differential water levels compared with reading the distance from the respective water surface to the top of the box wall – as had been done for the October, 2005 calibrations. Turbulence in the flow did result in some degree of water level fluctuation in the sight tubes, suggesting that additional measures to damp the impacts of the turbulence could lead to improved accuracy in reading the differential head. (See Conclusions sectsion)

At a nearby site, we looked at a potential demonstration site for automating a turnout gate to maintain a target water level in a buffer pond that is source to both a center pivot irrigation system and to a gated pipe irrigation system. Numerous center pivot systems have recently been installed in the district with similar buffer pond layouts. During unexpected pivot shutdowns – which are not uncommon with pivot systems – there is a need for control of flow into the buffer ponds to avoid overtopping. This could be accomplished by making minor programming changes to the Automated Farm Turnout technology developed at the WRRL.

On Friday afternoon, we performed calibrations at a site where the larger (5" X 22") of the two submerged orifices used at PID is installed. Again, a similar calibration procedure was followed using the Controlotron flow measurement equipment mounted on a section of 10" pipe. At this site, the submerged orifice is locateded inside the canal. Differential head was read using two staff gages installed on the orifice box walls. Differential head reading accuracy would be improved at this site by installing stilling wells either inside the box or in conjunction with taps in the box walls.

5. Conclusions: This effort to calibrate the selected flow measurement structures benefited significantly from Rudy's familiarity with the Controlotron equipment, and from improvements in the ability to read water levels at the submerged orifice structures. As noted above, further steps could be taken to improve the ability to accurately read water levels at these sites.

The CFM installation continues to be plagued by a programming glitch. In follow-up work by Ben Travers, Ben has discovered that somehow the Basic X software must have been accessing old code remaining on the laptop hard drive. He believes we now have the code issue fixed and he has purged all of the old code from the laptop. The updated code will need to be installed at the first opportunity to return to PID.

Plots showing field-measured data points are included in the appendix of this report. Based on information shown in these plots, representing data from both the recent trip and from the October, 2005 calibrations, the following observations and recommendations are presented:

- The recently-acquired calibration data for the smaller (4" X 18") submerged orifice displays considerably less scatter than the 2005 data. This can at least partly be attributed to improved ability to read head differentials resulting from installation of the site tubes. A review of the plotted data suggests that the rating curve developed from Equation 9-2 in the Water Measurement Manual appears to provide discharge values that agree well with the field calibration data. Continued use of the rating tables prepared using this rating is suggested for this size submerged orifice structures
- Recently-acquired calibration data for the larger (5" X 22") submerged orifice continues to display significant scatter. Expending efforts to improve the ability to accurately measure head differential at these structures are probably warranted. The relationship between data points from the field calibration and the rating curve developed from Equation 9-2 from the Water Measurement Manual for this structure is reasonable, but is not as close as the agreement seen for the 4" X 18" orifice calibration data. Continued use of the rating tables is suggested.
- The body of information available for identifying a rating relationship for elbow meters is quite limited. A range of factors that can affect observed pressure differential (i.e. location of pressure taps, upstream and downstream pipe configurations). Field calibration of an elbow meter probably provides the best opportunity for developing an accurate rating relationship between differential head and discharge. The distribution of field data points from both the current and the October 2005 calibrations is encouragingly uniform. An updated rating curve has been developed for this structure based on this body of data. (It should be noted that the previously utilized rating was derived from field calibration tests using a 10" aluminum mitered 90^{o} elbow in a pressurized delivery system.) The updated curve should provide improved accuracy in the calculated discharges at this structure.

- An evident trend seen in the plotted data is the generally lower measured discharge rates in the current data for observed differential heads at all structures that is seen in data from the October 2005 tests. A possible explanation for this is Rudy's greater level of familiarity with the Controlotron equipment. (The October, 2005 tests were the first Tom had operated the Controlotron equipment without assistance from someone with more experience.)

Gate control to maintain level (and prevent overtopping) at buffer ponds can contribute to water conservation in the system in a couple of ways. Most obviously, by preventing pond overtopping, flows lost to spill will be reduced, particularly in the case of unexpected center pivot shut downs. By operating to maintain a target level in the pond, the diversion will be kept fairly constant (assuming outflow from the pond remains constant). This would be in contrast to the typical conditions where a gate periodically adjusted in response to varying pond levels as the irrigator tries to fine the equilibrium gate setting through trial and error. The more constant turnout rates can be kept, fluctuations in the canal can be reduced, causing reduced impact on other water users due to fluctuating canal stage.

6. Action correspondence initiated: Tom will forward a new set of discharge tables for all three types of structures. (Tables for both submerged orifice sizes will remain unchanged.) Tom will seek to arrange to make a day trip to PID before the end of July to reinstall the CFM program at the elbow meter. Other tasks to be accomplished on this trip would include follow-up on the concept of an automated gate demonstration site, plus consideration of arrangements for a field day at PID, (possibly in September 2006).

cc: Jack Wergin (USBR Grand Island NE); Michael Kube (USBR NKAO); Dan Korf (Pioneer ID);

SIGNATURES AND SURNAMES FOR:

Travel to: Eastern Nebraska Area

Date or Dates of Travel: June 15-16, 2006

Names and Codes of Travelers: Tom Gill, 86-68560; Rudy Campbell, 86-68560

Traveler: _____ **_____**
Tom Gill, 86-68560 **Date**

Traveler: _____ **_____**
Rudy Campbell, 86-68560 **Date**

Noted and Dated by:

_____ **_____**
Clifford A. Pugh, Manager **Date**
Water Resources Research Laboratory